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What will the nutritional status of children and adolescents from North Korean defector families be after settling in South Korea?

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ABSTRACT

Objective: This study aimed to compare the nutritional status of children and adolescents from South Korean families and North Korean defector families who have settled and are currently living in South Korea.

Design: Children and adolescents from North Korean defector families were interviewed directly, whereas those from South Korean families used "The National Health and Nutrition Survey." Their nutritional statuses were estimated using the 2017 Korean National Growth Charts for children and adolescents.

Results: The overall prevalence of stunting, wasting, underweight, overweight, and obesity was 8.9%, 10.2%, 10.4%, 11.2%, and 12.2 respectively. However, the prevalence of stunting, wasting, underweight, overweight, and obesity for individuals settled in South Korea for <5 years was 11.0%, 10.4%, 13.0%, 10.4%, and 13.3, respectively, and that of individuals living in South Korea for ≥5 years was 9.3%, 7.0%, 11.6%, 9.3%, and 14.5%, respectively.

Conclusions: The children and adolescents from North Korean defector families experience double burden of malnutrition and obesity.

Keywords: Adolescents, Children, Democratic People's Republic of Korea, Nutrition, Defector

Strengths and limitations of this study

1. The results are hard to generalize to the whole population of children and youth of the North Korean defector households because the participants were not sampled through random sampling but convenience sampling.
2. Also, variables such as the educational level of the parents that could influence malnutrition, overweight, and obesity of children and youth were not compared.
3. Despite these limitations, this study has great significance in that growth status, malnutrition, overweight, and obesity were compared between children and youth of the North Korean defector households who were raised in South Korea after the entry and settlement in South Korea and children and youth of the South Korean households.

INTRODUCTION

According to the North Korean defectors policy data published by the Ministry of Unification, a total of 33,718 North Korean defectors entered South Korea as for September 2020. 5,097 children and youth aged 0–19 years

accounted for about 15% of the total defectors.[1] Since the North Korean defectors policy data only included children and youth born in North Korea, the number is estimated to be larger if the 3rd country-born or South Korean-born children or youth are included.[2] Moreover, as for September 2020, the number of children and youth of the North Korean defector households living in South Korea is expected to increase steadily in the future if we consider the fact that women tentatively comprise up to 72% of the total North Korean defectors and the proportion of child-bearing aged women is high among them.[1]

According to the National Nutrition Survey 2012 conducted by North Korea, United Nations International Children's Emergency Fund (UNICEF), United Nations World Food Program, and the European Union (UN) to verify the effect of the food aid programs of the international organizations, 35.1%, 4.6%, and 15.2% of the North Korean children aged <5 years were found to suffer from stunting, wasting, and underweight, respectively.[3] Based on the 2017 Multiple Indicator Cluster Survey conducted via support from UNICEF 5 years later, 19.1%, 2.5%, and 9.3% of the North Korean children were also reported to suffer from stunting, wasting, and underweight, respectively, and one-third of the children aged 6–23 months were unable to meet the minimum dietary standard.[4] Furthermore, the 2019 Food and Agriculture Organization survey on nutritional status showed that 1.1 million people comprising up to 43.4% of the whole population were malnourished in North Korea,[5] showing the still-deprived nutritional status of North Korea.

These food shortages are expected to have adversely affected the development and health of the children and the youth in North Korea.[6] Due to the food shortages, since the North Korean children and youth defectors were exposed to undernourishment during their early life including the fetal period, they are likely to have more risk factors for various chronic diseases than South Korean children and youth. Moreover, because children and youth of the North Korean defector households were unlikely to receive appropriate health management during their growth period due to the instability of life after the defection from North Korea, they are expected to have low health status.[7]

The nutritional status of infancy and childhood is related to the health problems of both the growth period and adulthood. The early life malnourishment leads to growth retardation and undersized body. Even if nutrition is well supplied afterward, the risks of adult diseases like diabetes mellitus or obesity increase considerably.[8] Adolescence is the period requiring the most nutrition, where the balanced nutrition intake and appropriate dietary habits during this period could lead to better physical health.[9] During the growth period, it is also important to form appropriate dietary habits because the dietary habits formed during this period do not change easily after one has reached adulthood.[10]

Previous studies on children and youth of the North Koran defector households mostly focused on adaptation to the South Korean society, and the studies related to health mostly focused on psychological and mental health status and reported that, due to difficulties faced during the adaptation to the South Korean society after defecting from North Korea and entering South Korea, children and youth were psychologically and mentally deprived.[11-14] Even though there was a study reporting deprivation of growth and nutritional status and lack of nutritional intake in children and youth of the North Korean defector households, it only examined the status right after the entry into South Korea.[15] To the best of our knowledge, there was no study focusing on the nutritional status of children and youth of the North Korean defector households after settlement in South Korean society.

In this study, we aimed to investigate the nutritional status of children and youth of the North Korean defector households after settlement in South Korean society using "2017 Korean National Growth Charts for Children and Adolescents" and compare their nutritional status to that of children and youth of the South Korean households.

METHODS

Participants

Children and youth of the North Korean defector households were defined as children and youth aged 0–18 years who are currently being raised in South Korea and were born in a household where at least one parent is a North Korean defector. A total of 527 participants were recruited from local Hana Centers, alternative schools, and non-governmental organizations (NGOs) across South Korea between September 2017 and December 2019.

Among the total 24,269 participants of the 7th Korea National Health and Nutrition Examination Survey (KNHANES VII) (2016–2018), children and youth of the South Korean households were defined as 4,880 children and youth aged 0–18 years.

Data collection methods

Children and youth of the North Korean defector households

We contacted parents and children of the North Korean defector households through local Hana Centers, alternative schools, and NGOs across South Korea between September 2017 and December 2019 to assess the growth and nutritional status of children and youth of the North Korean defector households. We thoroughly

explained the purpose and the details of the study to the contacted participants and informed them that they should participate voluntarily and could drop out anytime on their own will. Children younger than 7 years were deemed to have difficulties in communication; thus, the informed consent and the questionnaire responses were acquired from their guardians (surrogates). In children aged 7 years or older, the informed consent was acquired from both the participants and their guardians (surrogates), and the questionnaire responses were acquired from the participants only. The nutritional status of children and youth of the North Korean defector households was investigated via direct interviews using structured questionnaires, and the growth status was assessed by directly measuring height and weight via mobile stadiometer and scale. The study procedures were approved by the Bioethical Committee of Chosun University (IRB No. 2-1041055-AB-N-01-2017-0025).

Children and youth of the South Korean households

The data of KNHANES VII (2016–2018) were used for children and youth of the South Korean households.[16] The KNHANES calculates representative and reliable statistics regarding health status, health behavior, and food and nutrition intake behavior of Koreans through health survey, examination survey, and nutrition survey on a national and a provincial scale. KNHANES is being used as the basic data source for the healthcare policies such as setting and evaluating goals of the national health promotion plan or developing health promotion programs. In this study, among the total 24,269 participants of the KNHANES VII (2016–2018), 4,880 children and youth aged 0–18 years were defined as children and youth of the South Korean households, and the related data such as gender, age, and physical traits were used.

Investigated variables

General characteristics of the participants

We assessed gender, age, height (cm), and weight (kg) and calculated body mass index (BMI) as the general characteristics of the North Korean defector group and the South Korean group.

A mobile stadiometer and scale were used to measure the height and weight of children and youth of the North Korean defector households. InKids (InLab S50, InBody Co., Ltd., Seoul, Korea), an ultrasound stadiometer that can measure up to 200 cm on a 0.1 cm scale, was used as the stadiometer, and CAS HE-58 (CAS, Yangju, Korea),

a digital scale that can measure on a 0.1 kg scale, was used as the scale. Additionally, we examined country of birth (South Korea, North Korea, China, etc.), nationality of birth mother (South Korea, North Korea, China, etc.), nationality of birth father (South Korea, North Korea, China, etc.), and date of entry into South Korea.

We also examined the economic status of the household in the South Korean group. "Monthly income quartile" variables were used to describe the economic status of the households. The top 2 quarters were classified as "high," and the bottom 2 quarters were classified as "low." In KNHANES, the age was given in months in children aged 2–6 years, but the age was only given in years in children older than 6 years. Thus, in children 6 years or younger, the age was recorded in months as given, and in children older than 6 years, the age was recorded as the representative monthly age (age in years x 12 months).

Participants' growth status, malnutrition, overweight, and obesity

To assess the participants' growth status, we used the 2017 Korean National Growth Charts for Children and Adolescents.[17] 2017 Korean National Growth Charts for Children and Adolescents are percentile curves representing the distribution of physical trait values such as height and weight of South Korean children and adolescents. They were jointly developed by the Korean Pediatric Society and the Korea Disease Control and Prevention Agency in 2017 and are used as an index to assess the growth status of children and adolescents checking the presence of short stature, underweight, obesity, and so on. In 2017 Korean National Growth Charts, "World Health Organization (WHO) Growth Standards"[18] were introduced for children aged 3 years or younger to accurately assess the physical growth status of the children and adolescents. "WHO Growth Standards" were developed by only including breastfed infants to be used as the standards for breastfed infants. In the case of children aged 3–18 years, we used the same data from 2007 Korean National Growth Charts, but the height charts were adjusted upward and the criterion for obesity (BMI of ≥95th percentile) was adjusted downward to reflect the current status of the South Korean children and adolescents. In this study, the 2017 Korean National Growth Charts were used to calculate participants' height for age, weight for age, and BMI for age.

We compared malnutrition, overweight, and obesity of the participants of the study using the standards of the 2017 Korean National Growth Charts.[19] Stunting was defined as height for age of <3rd percentile for both children aged 0–23 months and children aged 2–18 years. Wasting was defined as weight for age of <5th percentile in children aged 0–23 months and as BMI for age of <5th percentile in children aged 2–18 years. Underweight was defined as weight for age of <5th percentile for both children aged 0–23 months and children aged 2–18

years. Overweight was defined as weight for age of ≥95th percentile in children aged 0–23 months and as BMI for age of ≥85th percentile and <95th percentile in children aged 2–18 years. Obesity was defined as BMI for age of ≥95th percentile in children aged 2–18 years.

Data analysis

The statistical program SPSS 25.0 (IBM Corp., Armonk, NY, USA) was used to analyze the collected data. The general characteristics of the participants were analyzed using frequency, percentage, mean, and standard deviation (SD). Independent t-test for the mean of the growth status and chi-square test and Fisher's exact test for the proportional distribution of malnutrition, overweight, and obesity were used to evaluate the significance of the differences between the North Korean defector group and the South Korean group. To assess the odds ratio (OR) of malnutrition, overweight, and obesity prevalence of the North Korean defector group compared to the South Korean group, logistic regression analysis was performed with gender and age adjustment. Statistical significance was defined as a p-value of <0.05 in all analyses.

RESULTS

Comparison of the general characteristics

The total number of participants was 5,407 consisting of 527 children and youth of the North Korean defector households and 4,880 children and youth of the South Korean households. In the North Korean defector household group, there were 227 males (52.6%) and 250 females (47.4%), and in the South Korean household group, there were 2,513 males (51.5%) and 5,367 females (48.5%). In the North Korean defector household group, there were 35 children aged 0–23 months (6.6%) and 492 children aged 24 months or older (93.4%), and in the South Korean household group, there were 262 children aged 0–23 months (5.4%) and 4,618 children aged 24 months or older (94.6%).

In South Korea of the North Korean defector group, the settlement duration was 4.2 ± 3.4 years on average. Among the North Korean defector household group, the most common country of birth was China (235, 45.7%) followed by South Korea (37.4%) and North Korea (16.7%). In the North Korean defector household group, the most common nationality of birth mother was North Korea (504, 96.9%), and the most common nationality of birth father was China (262, 50.7%).

In the South Korean household group, there were 3,152 high-income households (64.2%) and 1,743 low-income households (35.8%) (Table 1).

Table 1. General characteristics

Variable	Total	North Korean refugee families	South Korean families
Number	5,407 (100.0)	527 (9.7)	4,880 (90.3)
Sex			
Male	2,790 (51.6)	227 (52.6)	2,513 (51.5)
Female	2,617 (48.4)	250 (47.4)	2,367 (48.5)
Age (month)	116.0 ± 61.3	133.0 ± 65.2	114.2 ± 60.6
0–23	297 (5.5)	35 (6.6)	262 (5.4)
≥24	5,110 (94.5)	492 (93.4)	4,618 (94.6)
Age (year)	9.2 ± 5.1	10.6 ± 5.4	9.1 ± 5.1
Height (cm)	134.6 ± 28.5	138.3 ± 29.6	134.2 ± 28.3
Weight (kg)	36.6 ± 20.1	40.3 ± 20.3	36.2 ± 20.0
BMI (kg/m²)	18.4 ± 3.9	19.4 ± 4.1	18.3 ± 3.8
Country of birth			
South Korea		192 (37.4)	
North Korea		86 (16.7)	
China		235 (45.7)	
Others		1 (0.2)	
Duration of settlement (year)		4.2 ± 3.4	
<5 years		186 (65.5)	
≥5 years		98 (34.5)	

Nationality of birth mother			
South Korea		10 (1.9)	
North Korea		504 (96.9)	
China		6 (1.2)	
Nationality of birth father			
South Korea		113 (21.9)	
North Korea		138 (26.7)	
China		262 (50.7)	
Other		4 (0.8)	
Monthly household income			
Low			1,743 (35.8)
High			3,125 (64.2)

Values are presented as number (%) or mean ± standard deviation

Comparison of malnutrition, overweight, and obesity

The results of the comparison of malnutrition, overweight, and obesity between the North Korean defector group and the South Korean group are as follows.

The prevalence of stunting, wasting, underweight, overweight, and obesity was 8.9%, 10.2%, 10.4%, 11.2%, and 12.2%, respectively, in the North Korean defect group and 1.7%, 8.1%, 5.7%, 8.4%, and 9.4%, respectively, in the South Korean group. The North Korean defector group was higher in all 5 categories, and there was a significant difference in stunting ($p < 0.001$), wasting ($p < 0.001$), and overweight ($p = 0.032$) (Table 2).

Table 2. Comparison of growth between South Korean families and North Korean refugee families

Variable	Total	North Korean refugee families	South Korean families	P-value
Percentile of height for age	55.5 ± 29.1	45.4 ± 31.3	56.6 ± 28.6	<0.001
Percentile of	51.5 ± 31.1	50.5 ± 33.0	51.6 ± 30.9	0.432

weight for age				
Percentile of weight for height	50.2 ± 32.4	56.5 ± 34.0	49.5 ± 33.1	<0.001
Percentile of body mass index for age	47.9 ± 32.5	52.3 ± 34.3	47.4 ± 32.2	0.001

Values are presented as mean ± standard deviation

Comparison of malnutrition, overweight, and obesity according to the duration of settlement in South Korea

The results of the comparison of malnutrition, overweight, and obesity according to the duration of settlement in South Korea are as follows.

The prevalence of stunting, wasting, underweight, overweight, and obesity was 11.0%, 10.4%, 13.0%, 10.4%, and 13.3%, respectively, in the group of <5 years of settlement and 9.3%, 7.0%, 11.6%, 9.3%, and 14.5%, respectively, in the group of ≥5 years of settlement. Malnutrition was lower in the ≥5 years group than that in the ≥5 years group, and obesity was higher in the ≥5 years group than that in the ≥5 years group. However, no significant difference was observed between the groups (Table 3).

Table 3. Comparison of the prevalence of malnutrition, overweight, and obesity between South Korean families and North Korean refugee families

Variable	Total	North Korean refugee families	South Korean families	P-value
Stunting	131 (2.4)	47 (8.9)	84 (1.7)	<0.001
Wasting	451 (8.3)	54 (10.2)	397 (8.1)	<0.001
Underweight	333 (6.2)	55 (10.4)	278 (5.7)	0.096
Overweight	470 (8.7)	59 (11.2)	411 (8.4)	0.032
Obesity	496 (9.7)	60 (12.2)	436 (9.4)	0.050

Values are presented as number (%)

Comparison of malnutrition, overweight, and obesity according to monthly household income

The results of the comparison of malnutrition, overweight, and obesity according to monthly household income are as follows.

The prevalence of stunting, wasting, and underweight according to monthly household income was 1.1%, 8.4%, and 5.3%, respectively, in the high-income South Korean households, 2.8%, 7.7%, and 6.4%, respectively, in the low-income South Korean households, and 8.7%, 10.0%, and 10.2%, respectively, in the North Korean defector households. The prevalence of stunting, wasting, and underweight was significantly different between the groups ($p < 0.001$).

The prevalence of obesity was 8.7% in the high-income South Korean households, 10.8% in the low-income South Korean households, and 11.9% in the North Korean defector households showing a significant difference ($p = 0.015$) between the groups. The prevalence of malnutrition, overweight, and obesity was higher in the North Korean defector household group than that in the South Korean household group (Table 4).

Table 4. Comparison of the prevalence of malnutrition, overweight, and obesity according to duration of settlement in South Korea

Variable	North Korean refugee families		P-value
	Duration of settlement <5 Year	Duration of settlement ≥5 Year	
Stunting	17 (11.0)	8 (9.3)	0.673
Wasting	16 (10.4)	6 (7.0)	0.380
Underweight	20 (13.0)	10 (11.6)	0.760
Overweight	16 (10.4)	8 (9.3)	0.788
Obesity	20 (13.3)	12 (14.5)	0.811

Values are presented as number (%)

Comparison of the prevalence of malnutrition, overweight, and obesity

The results of logistic regression analysis to assess the OR of malnutrition, overweight, and obesity prevalence between the North Korean defector and South Korean groups are as follows.

The North Korean defector group showed higher prevalence of stunting (OR: 5.59; 95% confidence interval (CI): 3.87–8.09), wasting (OR: 1.29; 95% CI: 0.96–1.74), underweight (OR: 1.93; 95% CI: 1.42–2.62), overweight (OR: 1.37; 95% CI: 1.03–1.83), and obesity (OR: 1.33; 95% CI: 1.00–1.78). All differences were significant except in the case of wasting. After gender and age adjustment, logistic regression analysis yielded an OR of 5.62 (95% CI: 3.88–8.15), 1.88 (95% CI: 1.38–2.55), and 1.32 (95% CI: 1.00–1.77) for stunting, underweight, and overweight, respectively, which were found to be significant. The results of growth status of children and adolescents from North Korean defectors in the 2017 Korean National Growth Charts for Children and Adolescents are shown in Figure 1.

Figure 1. Distribution of height and weight of North Korean defector children and adolescents

DISCUSSION

This study aimed to assess the nutritional status of children and youth of the North Korean defector households after settlement in South Korea. The prevalence of malnutrition, overweight, and obesity was surveyed in 527 children and youth of the North Korean defector households and 4,880 children and youth of the South Korean households.

Children and youth of the North Korean defector households had a mean duration of settlement of 4.2 ± 3.4 years in South Korea. As a result of logistic regression analysis comparing the prevalence of malnutrition, overweight, and obesity in the North Korean defector group to that in the South Korean group, the ORs were 5.59 (95% CI: 3.87–8.09), 1.93 (95% CI: 1.42–2.62), 1.37 (95% CI: 1.03–1.83), and 1.33 (95% CI: 1.00–1.78) for stunting, wasting, overweight, and obesity, respectively, and there were significant differences. Based on these results, we could find out that children and youth of the North Korean defector households had more nutritional problems such as malnutrition, overweight, and obesity while growing up after settlement in South Korea than children and youth of the South Korean households.

Previous studies regarding malnutrition of children and youth of the North Korean defector households showed that the 2005 study assessed the physical condition of the North Korean children and youth defectors in Hanawon

right after entering South Korea. The study showed a worrisome growth status of 33.3% of short stature and 38,9% of underweight in the North Korean children and youth defectors[20]. Another study examined the growth, developmental, and nutritional status of the North Korean children and youth defectors who entered South Korea from 2009 to 2010. Compared to the South Korean standard at the time, children of the North Korean defector households showed 19% and 15% shortfall in height and weight, respectively[21]. About 4 years have passed since the participants of this study settled in South Korea, and the participants showed 8.9%, 10.2%, and 10.4% of stunting, wasting, and underweight, respectively, implying improvement of the status compared to the status of children right after entering South Korea based on the previous studies. However, children and youth of the North Korean defector households still seem to suffer from malnutrition showing 5.50 times higher stunting prevalence and 1.93 times higher wasting prevalence than children and youth of the South Korean households. In this study, the prevalence of stunting, wasting, and underweight was reported to be lower in the group of ≥5 years of settlement in South Korea than that in the group of <5 years of settlement in South Korea with the prevalence of 1.7%, 3.4%, and 1.4%, respectively. This improvement of nutritional status was thought to result from the improvement of nutritional status as the quality of the meal rose as the North Korean children and youth defectors moved from the food-deprived environment to the food-abundant environment in South Korea and the duration of settlement in South Korea increased[22]. However, previous studies have reported less nutrition uptake in the North Korean defectors after settlement in South Korea compared to the original members of South Korea[23] and less energy and nutrition uptake in the North Korean children and youth defectors compared to the South Korean children due to lack of nutritional education after settlement in South Korea and difficulties in adapting to South Korean society even if they have received adequate nutritional education.[22] These previous study results reveal that children and youth of the North Korean defector households are still suffering from malnutrition.

A previous study regarding overweight and obesity in children and youth of the North Korean defector households has shown that no North Korean children defectors exceeded 97 percentile body weight, a criterion of obesity right after entering South Korea from 2009 to 2010.[15] However, children and youth of the North Korean defector households aged 6–18 years residing in Seoul and Incheon during the same period showed higher fat uptake and had a higher possibility of being obese than children of the South Korean households.[22] Thus, children and youth of the North Korean defector households who have settled and are currently living in South Korea are expected to show higher obesity prevalence than the South Korean children. A previous study investigating North Korean adolescent defectors staying in China after defection reported that most North Korean adolescent defectors were suffering from growth retardation or underweight and the average height and weight of

the North Korean adolescent defectors who entered South Korea were reported to fall short of the average height and weight of the South Korean adolescents.[20] Notably, as children reach adolescence, the difference in height and weight between South Korean children and North Korean children is drastically widening. Previous study results point out that because North Korean adolescent defectors have long been deprived of nutrition before their settlement in South Korea, even though they are continuously being nourished after the settlement, their weight is increasing instead of their height leading to obesity.[6] The same study also reports that the prevalence of obesity was 1.3 times higher in children and youth of the North Korean defector households than that in children and youth of the South Korean households and the prevalence of obesity increased as the duration of settlement in South Korea increased, with 13.3% obesity prevalence in the group of <5 years of settlement in South Korea and 14.5% obesity prevalence in the group of ≥5 years of settlement in South Korea. This phenomenon is thought to result from the tendency that people become more obese as people migrate from the low-income country to the high-income country and due to high-fat and high-calorie meals that are introduced.[24] Based on the previous study results that if the food intake in the early life is insufficient, the metabolism changes to not using fat as an energy source,[25] children and youth of the North Korean defector households seem to have a tendency to preserve fat in the body rather than use the fat as an energy source. The phenomenon of insufficient food intake in the early life leading to changes of metabolism to using less fat as an energy source,[25] can be explained by "thrifty phenotype hypothesis." "Thrifty phenotype hypothesis" is a hypothesis that when the fetus is in a poor growth condition, less important organs are sacrificed to preserve the important organs such as brain or heart. Furthermore, insulin resistance can also increase according to "thrifty phenotype hypothesis" leading to a higher risk of diabetes mellitus and induction of childhood obesity. Thus, chronic diseases like type 2 diabetes mellitus are more likely to be affected by fetal conditions rather than by genetics.[26] Children and youth of the North Korean defector households are thought to have impoverished growth condition due to early malnutrition and have a higher possibility of being obese as they grow up.

After assessing malnutrition, overweight, and obesity according to monthly household income, children of the North Korean defector households were reported to have a higher prevalence of malnutrition, overweight, and obesity than the children of the low-income South Korean households. These results imply that the nutritional status was more unbalanced in children of the North Korean defector households than that in the children of the low-income South Korean households. Another study examining the socioeconomic status of the North Korean defectors currently residing in South Korea showed that the mean monthly income of the North Korean defectors in 2020 was 1.364 million won which was very low compared to the South Korea's mean monthly income of

3.116 million won.[27] Taking into consideration the fact that the mean monthly income of the low-income South Korean households was about 1.8 million won,[16] it can be assumed that the economic status of the North Korean defectors is more impoverished than that of the low-income South Korean households. Also, in a previous study assessing health status according to income, economically vulnerable groups such as low-income people were reported to have poor health status as a result of the accumulation of socioeconomic inequalities in areas including income, medical insurance, and education from an early age.[28-30] Based on these studies, North Korean defectors are currently in more impoverished condition than the low-income South Korean households, and these economic conditions are thought to have influenced the nutritional and growth status of children of the North Korean defector households. In studies examining the relationship between health status, obesity prevalence, and socioeconomic status published in South Korea from the early 2000s to 2011, the risk of obesity was reported to be higher in the low socioeconomic group than that in the high socioeconomic group.[31-34] Immigrants including North Korean defectors were likely to have low economic status,[35] social position, and educational level in South Korea leading to a higher possibility of living in relative impoverished condition and experience health disparity.[36] Also, based on the study results that children of low-income households and North Korean defectors are more unlikely to receive adequate support or information compared to South Korean adolescents due to relatively unbalanced nutrition uptake and other socioeconomic factors,[35] low economic status of North Korean defector households is thought to be the cause of higher meal skipping rate and inadequate meals leading to malnutrition, overweight, and obesity. These results showed that children and youth of the North Korean defector households are in the economically vulnerable group due to difficulties in adapting after settlement in South Korean society,[37] still experience malnutrition due to inadequate food and nutrition uptake, and are thought to be in poor nutritional status compared to the original South Korean children. Improvement in the nutritional status of children and youth of the North Korean defector households is needed through continuous follow-up.

In this study, compared to children and youth of the South Korean households, children and youth of the North Korean defector households were reported to have nutritional problems such as malnutrition, overweight, and obesity while growing up after settlement in South Korea. Children who experienced severe malnutrition during the growth period had a higher possibility of developing extensive functional disabilities such as decreased immune response, decreased physical fitness, and cognitive and emotional retardation when they are in their adulthood leading to a long-term negative societal effect.[15] In the growth period, overweight and obesity can lead to adult obesity- and obesity-related complications such as metabolic syndrome.[38] Thus, further examination and management of malnutrition, overweight, and obesity in children and youth of the North Korean

defector households are needed.

In conclusion, this study has significance in that the study assessed the nutritional status of children and youth using "2017 Korean National Growth Charts for Children and Adolescents." Growth charts are commonly used in assessing the nutritional status of children and youth. Growth charts are curves representing the distribution of physical trait values such as height and weight of children and youth. Growth charts are used as important criteria in assessing short stature, underweight, and obesity. "WHO Child Growth Standards," international growth standards developed by WHO, are used worldwide to assess nutritional status during infancy and childhood.[18] According to "WHO Child Growth Standards," stunting is defined as height for age of Z-score <−2 SD, underweight as a weight for age of Z-score <−2 SD, wasting as a weight for height of Z-score <−2 SD, and obesity as BMI for age of Z-score >2 SD.[39] In "2017 Korean National Growth Charts for Children and Adolescents," for children aged younger than 3 years, "WHO Growth Standards" which are acknowledged as international standards were introduced. For children aged 3 years or older, the criterion of short stature was adjusted upward and the criterion for obesity (BMI of ≥95th percentile) was adjusted downward to avoid underevaluation of short stature and obesity and to reflect the current height of the children and youth based on the existing growth charts. As a result, the growth status of children and youth of the South Korean households and malnutrition of children and youth of the North Korean defector households could be evaluated based on the South Korean standards.

There are some limitations to this study. The results are hard to generalize to the whole population of children and youth of the North Korean defector households because the participants were not sampled through random sampling but convenience sampling. Also, variables such as the educational level of the parents that could influence malnutrition, overweight, and obesity of children and youth were not compared. Despite these limitations, this study has great significance in that growth status, malnutrition, overweight, and obesity were compared between children and youth of the North Korean defector households who were raised in South Korea after the entry and settlement in South Korea and children and youth of the South Korean households. The development of the program to assess the growth status of children and youth of the North Korean defector households and improve nutritional status through further follow-up is required.

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Not applicable.

CONTRIBUTORSHIP STATEMENT

SWC and SYK conceived the idea. SWC and SYK collected data and performed literature search. JP, SYR, MAH, and SYP developed analysis plan. SYK analyzed the data under the supervision of SWC. SYK drafted the paper. All authors contributed to the interpretation of results and in making an important intellectual contribution to the manuscript. All authors read and approved the final manuscript.

COMPETEING INTERESTS

None declared.

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Ethics Approval

The study procedures were approved by the Bioethical Committee of Chosun University (IRB No. 2-1041055-AB-N-01-2017-0025).

We thoroughly explained the purpose and the details of the study to the contacted participants and informed them that they should participate voluntarily and could drop out anytime on their own will. Children younger than 7 years were deemed to have difficulties in communication; thus, the informed consent and the questionnaire responses were acquired from their guardians (surrogates). In children aged 7 years or older, the informed consent was acquired from both the participants and their guardians (surrogates), and the questionnaire responses were acquired from the participants only.

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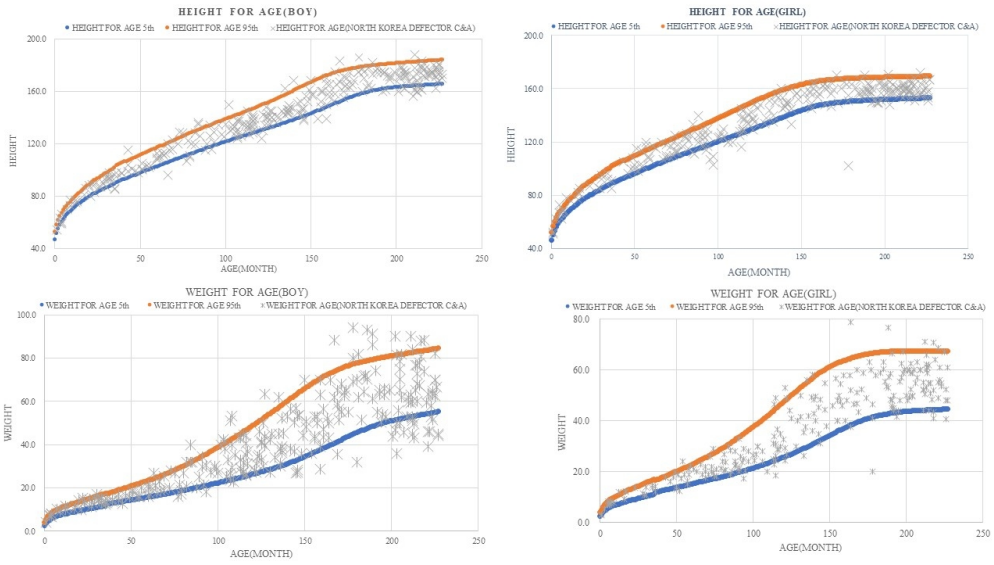

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-11
		(b) Give reasons for non-participation at each stage	7-11
		(c) Consider use of a flow diagram	7-11
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-11
		(b) Indicate number of participants with missing data for each variable of interest	7-11
Outcome data	15*	Report numbers of outcome events or summary measures	7-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-11

		(*b*) Report category boundaries when continuous variables were categorized	7-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Comparing the nutritional status of children and adolescents from North Korean defector families and South Korean families.

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ABSTRACT

Objective: This study aimed to investigate the nutritional status of children and adolescents from North Korean defector (NKD) families who are currently living in South Korea (SK) and compared with the status of those from SK families.

Design: A cross-sectional study comparing the prevalence of malnutrition, overweight, and obesity between children and adolescents from NKD families and SK families.

Setting : Children and adolescents from NKD families were interviewed face-to-face directly, whereas the data about those from SK families acquired by using 2017 Korea National Health and Nutrition Examination Survey(KNHANES). Their nutritional status were estimated using the 2017 Korean National Growth Charts for children and adolescents.

Participants: The total number of children and adolescents was 2,136 consisting of 527 subjects from the NKD families and 1,609 subjects from the SK families.

Results: The overall prevalence of stunting, wasting, underweight, overweight, and obesity in NKD group was 8.9%, 10.2%, 10.4%, 11.2%, and 12.2% respectively, and 1.9%, 7.1%, 5.9%, 9.2%, and 9.3%, respectively, in SK families. The NKD group showed significantly higher prevalence than SK group in stunting($p<0.001$), wasting($p=0.014$), underweight($p<0.001$), obesity($p=0.041$) but not in overweight.

Conclusions: The nutritional status of children and adolescents form NKD families was worse than that of those from SK families, and also higher prevalence of obesity.

Keywords: Adolescents, Children, Democratic People's Republic of Korea, Nutrition, Defector

Strengths and limitations of this study

1. This study is significant in that it is the first large-scale comparison of the nutritional status of children and adolescents of NKD families and those of SK families.
2. Because participants of NKD families were drawn with convenience sampling, the findings are difficult to generalize.
3. Variables that could affect nutritional status such as education level could not be collected.

INTRODUCTION

According to the North Korean defectors (NKD) data published by the Ministry of Unification, a total of 33,718 NKD entered South Korea(SK) as of September 2020. About 15% of all defectors 5,097 are children and adolescents aged 0–19 years.[1] Since the NKD data only included children and adolescents born in North

Korea(NK), the number is estimated to be larger if the 3rd country-born or SK-born children or adolescents are included.[2] Moreover, as for September 2020, the number of children and adolescents of the NKD families living in SK is expected to increase steadily in the future if we consider the fact that women tentatively comprise up to 72% of the total NKDs and the proportion of child-bearing aged women is high among them.[1]

According to the 2012 National Nutrition Survey, NK verified the effectiveness of its food aid program on 35.1%, 4.6%, and 15.2% of NK children. Each was found to be suffering from malnutrition.[3] Based on the 2017 Multiple Indicator Cluster Survey(MISC) conducted via support from UNICEF 5 years later, 19.1%, 2.5%, and 9.3% of the NK children were also reported to suffer from stunting, wasting, and underweight, respectively, and one-third of the children aged 6–23 months were unable to meet the minimum dietary standard.[4] Furthermore, the 2019 Food and Agriculture Organization(FAO) survey on nutritional status showed that 1.1 million people comprising up to 43.4% of the whole population were malnourished in NK,[5] showing the still-deprived nutritional status of NK.

These food shortages are expected to have adversely affected the growth and health of the children and the adolescents in NK.[6] Due to the food shortages, since the NK children and adolescents were exposed to undernourishment during their early life including the fetal period, they are likely to have more risk factors for various chronic diseases than SK children and adolescents. Moreover, because children and adolescents of the NKD families were unlikely to receive appropriate health management during their growth period due to the instability of life after the defection from NK, they are expected to have-poor health status.[7]

The nutritional status of infancy and childhood is related to the health problems of both the growth period and adulthood. The early life malnourishment leads to growth retardation and undersized body. Adolescence is the period requiring the most nutrition, where the balanced nutrition intake and appropriate dietary habits during this period could lead to better physical health.[8] During the growth period, it is also important to form appropriate dietary habits because the dietary habits formed during this period do not change easily after one has reached adulthood.[9]

Previous studies on children and adolescents of the NKD families mostly focused on adaptation to the SK society, and the studies related to health mostly focused on psychological and mental health status and reported that, due to difficulties faced during the adaptation to the SK society after defecting from NK and entering SK, children and adolescents were psychologically and mentally deprived.[10-13] Even though there was a study

reporting deprivation of growth and nutritional status and lack of nutritional intake in children and adolescents of the NKD families, it only examined the status right after the entry into SK.[14] To the best of our knowledge, there was no study focusing on the nutritional status of children and adolescents of the NKD families after settlement in SK society.

We aimed to investigate the nutritional status of children and adolescents of the NKD families after settlement in SK society and compare their nutritional status to that of children and adolescents of the SK families.

METHODS

Participants

Children and adolescents of the NKD families were defined as those aged 0–18 years who are currently being raised in SK and were born in families where at least one parent is an NKD. A total of 527 participants were recruited from local Hana Centers, alternative schools, and non-governmental organizations (NGOs) across SK between September 2017 and December 2019.

Among the total of 8,127 participants of 2017 Korea National Health and Nutrition Examination Survey (2017 KNHANES), children and adolescents of the SK families were defined as 1,609 children and adolescents aged 0–18 years.

Patient and Public Involvement

This study was done without involving patients or members of the public in the design, conduct, reporting and disseminating plans of the research.

Data collection methods

Children and adolescents of the NKD families

We contacted participants of the NKD families through local Hana Centers, alternative schools, and NGOs across SK between September 2017 and December 2019. We thoroughly explained the purpose and the details of the study to the contacted participants and informed them that they could participate voluntarily and could drop out

anytime on their own will. Children younger than 7 years were deemed to have difficulties in communication; thus, the informed consent and the questionnaire responses were acquired from their guardians (surrogates). In children aged 7 years or older, the informed consent was acquired from both the participants and their guardians (surrogates). Trained researchers face to face interviewed the participants using structured questionnaires, and measured height and weight.

Children and adolescents of the SK families

The data for children and adolescents of SK families were acquired using 2017 KNHANES data. The KNHANES calculates representative and reliable statistics regarding health status, health behavior, and food and nutrition intake behavior of Koreans through health survey, examination survey, and nutrition survey on a national and a provincial scale.[15] KNHANES is being used as the basic data source for the healthcare policies such as setting and evaluating goals of the national health promotion plan or developing health promotion programs. In this study, among the total 8,127 participants of 2017 KNHANES, 1,609 children and adolescents aged 0–18 years were defined as children and adolescents of the SK families.

Investigated variables

General characteristics of the participants

For children and adolescents of NKD families, sex, age, country of birth, duration of settlement, nationality of birth mother, nationality of birth father were surveyed. Height was measured using the mobile InKids height meter (InLab S50, InBody Co., Ltd., Seoul, Korea) and weight was measured using the CAS HE-58 scale (CAS, Gyeonggi-do, Korea). Body mass index (BMI) was calculated as the weight (kg) divided by the square of height(m^2).

For children and adolescent of SK families, the data of sex, age, height, weight, and quartile of monthly household income were acquired from 2017 KNHANES data. We defined the socioeconomic status using quartile of monthly household income and recategorized as high (highest and medium-high) and low (medium-low and lowest). In

KNHANES, the age was given in months in children aged 2–6 years, but the age was only given in years in children older than 6 years. Thus, in children 6 years or younger, the age was recorded in months as given, and in children older than 6 years, the age was recorded as the representative monthly age (age in years x 12 months).

Participants' growth status, malnutrition, overweight, and obesity

To assess the participants' growth status, we used the 2017 Korean National Growth Charts (KNGC).[16] The KNGC are percentile curves representing the distribution of physical trait values such as height and weight of SK children and adolescents. They were jointly developed by the Korean Pediatric Society and the Korea Disease Control and Prevention Agency in 2017 and are used as an index to assess the growth status of children and adolescents checking the presence of short stature, underweight, obesity, and so on. In 2017 KNGC, World Health Organization (WHO) Growth Standards [17] were introduced for children aged 3 years or younger to accurately assess the physical growth status of the children and adolescents. WHO Growth Standards were developed by including breastfed infants only to be used as the standards for breastfed infants. In the case of children aged 3–18 years, we used the same data from 2007 KNGC, but the height charts were adjusted upward and the criterion for obesity (BMI of ≥95th percentile) was adjusted downward to reflect the current status of the SK children and adolescents.

We compared malnutrition, overweight, and obesity of participants using the standards of the 2017 KNGC.[18] Stunting was defined as height for age of <3rd percentile for both children aged 0–23 months and children aged 2–18 years. Wasting was defined as weight for age of <5th percentile in children aged 0–23 months and as BMI for age of <5th percentile in children aged 2–18 years. Underweight was defined as weight for age of <5th percentile for both children aged 0–23 months and children aged 2–18 years. Overweight was defined as weight for age of ≥95th percentile in children aged 0–23 months and as BMI for age of ≥85th percentile and <95th percentile in children aged 2–18 years. Obesity was defined as BMI for age of ≥95th percentile in children aged 2–18 years.

Data analysis

The statistical program SPSS version 25 was used to analyze the collected data. The general characteristics of the

participants were analyzed using frequency, percentage, mean, and standard deviation (SD). Independent t-test for the mean of the growth status and chi-square test and Fisher's exact test for the proportional distribution of malnutrition, overweight, and obesity were used to evaluate the significance of the differences between two groups. Statistical significance was defined as a p-value of overweight, and obesity prevalence of the NKD <0.05 in all analyses.

RESULTS

Comparison of the general characteristics

The general characteristics of total 2,136 subjects (527 in NKD group and 1,609 in SK group) are shown in table 1. In the NKD group, there were 35 (6.6%) children aged 0–23 months and 492 (93.4%) children aged 24 months or older, and in the SK household group, there were 74 (4.6%) children aged 0–23 months and 1,535 (95.4%) children aged 24 months or older. The duration of settlement was 4.2 ± 3.4 (Mean±SD) years. The most common nationality of birth mother was NK(96.9%), and the most common nationality of birth father was China(50.7%).

Table 1. General characteristics

Variable	Total	North Korean Defector group	South Korean Group
Number	2,136(100.0)	527(24.7)	1,609(75.3)
Sex			
Boy	1,120(52.4)	277(52.6)	843(52.4)
Girl	1,016(47.6)	250(47.4)	766(47.6)
Age(month)	119.7±61.7	133.0±65.2	115.4±59.91
0-23	109(5.1)	35(6.6)	74(4.6)
≥24	2,027(94.9)	492(93.4)	1,535(95.4)
Age(year)	9.5±5.1	10.6±5.4	9.2±5.0
Height(cm)	135.8±28.4	138.3±29.6	134.9±28.0
Weight(kg)	37.5±19.9	40.3±20.3	36.5±20.0
BMI(kg/m^2)	18.7±3.9	19.4±4.1	18.4±3.8

Country of birth	
South Korea	192(37.4)
North Korea	86(16.7)
China	235(45.7)
Other	1(0.2)
Duration of settlement(year)	4.2±3.4
<5years	186(65.5)
≥5years	98(34.5)
Nationality of birth mother	
South Korea	10(1.9)
North Korea	504(96.9)
China	6(1.2)
Nationality of birth father	
South Korea	113(21.9)
North Korea	138(26.7)
China	262(50.7)
Other	4(0.8)
Monthly household income	
Low	566(35.2)
High	1041(64.8)

Values are presented as number (%) or mean ± standard deviation

Comparison of the prevalence of malnutrition, overweight, and obesity

The prevalence of stunting, wasting, underweight, overweight, and obesity was 8.9%, 10.2%, 10.4%, 11.2%, and 12.2%, respectively, in the NKD group; 1.9%, 7.1%, 5.9%, 9.2%, and 9.3%, respectively, in the SK group. The The NKD group showed significantly higher prevalence than SK group in stunting(p<0.001), wasting(p=0.014), underweight(p<0.001), obesity(p=0.041) but not in overweight (Table 2).

Table 2. Comparison of the prevalence of malnutrition, overweight, and obesity between South Korean group and North Korean Defector group

Variable	Total	North Korean Defector group	South Korean group	*p-value*
Stunting	77(3.6)	47(8.9)	30(1.9)	<0.001
Wasting	168(7.9)	54(10.2)	114(7.1)	0.014
Underweight	150(7.0)	55(10.4)	95(5.9)	<0.001
Overweight	207(9.7)	59(11.2)	148(9.2)	0.105
Obesity	203(9.5)	60(12.2)	143(9.3)	0.041

Values are presented as number (%)

Comparison of malnutrition, overweight, and obesity according to monthly household income

The comparison of malnutrition, overweight, and obesity according to monthly household income are shown in table 3. The prevalence of stunting, wasting, underweight, overweight, and obesity was 1.1%, 7.9%, 5.8%, 9.3%, and 9.0% in the high-income SK group; 3.4%, 5.7%, 6.2%, 9.0% and 9.9% in the low-income SK group; 8.9%, 10.2%, 10.4%, 11.2%, and 12.1% in the NKD group. There were significant difference in the prevalence of stunting (p<0.001), wasting (p=0.020), and underweight (p=0.002), but not in overweight and obesity.

Table 3. Comparison of the malnutrition, overweight, and obesity according to monthly household income

Variable	South Korean group		North Korean Defector group	*p-value*
	High	Low		
Stunting	11(1.1)	19(3.4)	47(8.9)	<0.001
Wasting	82(7.9)	32(5.7)	54(10.2)	0.020
Underweight	60(5.8)	35(6.2)	55(10.4)	0.002

Overweight	37(9.3)	51(9.0)	29(11.2)	0.415
Obesity	91(9.0)	52(9.9)	60(12.1)	0.169

Values are presented as number (%)

DISCUSSION

In this study, we investigated the nutritional status of children and adolescents from NKD families and compared with the status of those from SK families. Our result demonstrated that the prevalence of stunting, wasting, underweight and obesity of NKD group were significantly higher than those of SKD group. Based on these results, we could find out that children and adolescents of the NKD families had more nutritional problems than those of the SK families. Children who experienced severe malnutrition during the growth period had a higher possibility of developing extensive functional disabilities such as decreased immune response, decreased physical fitness, and cognitive and emotional retardation when they are in their adulthood leading to a long-term negative societal effect.[14] In the growth period, overweight and obesity can lead to adult obesity- and obesity-related complications such as metabolic syndrome.[19] Thus, further examination and management of malnutrition, overweight, and obesity in children and adolescents of the NKD families are needed.

Previous studies have evaluated the malnutrition of children and adolescents of the NKD families. In one study, the researchers assessed the physical condition of the NK children defectors in Hanawon right after entering SK. They reported a worrisome growth status of 33.3% of short stature and 38,9% of underweight[20]. Another study examined the growth, developmental, and nutritional status of the NK children and adolescents who entered SK from 2009 to 2010. Compared to the SK standard at the time, children of the NKD families showed 19% and 15% shortfall in height and weight, respectively [21]. Though the participants of the study settled in SK about 4 years, there were 8.9%, 10.2%, and 10.4% of stunting, wasting, and underweight, respectively, implying children and adolescents of the NKD families still seem to suffer from malnutrition.

Our results demonstrated that the prevalence of obesity of NKD group was significantly higher than that of SK group. When NKDs entered into SK, only malnutrition was a nutritional problem in NKD children. However, the prevalence of obesity has been increasing as the duration of settlement increases [22]. In previous study comparing the nutritional intake level, children of NKD families had higher rates of fat intake than those of SK families [20,22]. Inadequate food intake in early childhood can alter metabolic processes, reducing the use of fat as an

energy source, which in turn accumulates in the body[21,22] and increases the risk of obesity [22-24]

In our results, the malnutrition prevalence of NKD group was higher than that of low-income SK group. In the study examining the socioeconomic status of the NKDs currently residing in SK, the authors reported that the mean monthly income of the NKDs in 2020 was only one third of the SK's mean monthly income.[23] Economically vulnerable groups such as low-income people were reported to have poor health status as a result of the accumulation of socioeconomic inequalities in areas including income, medical insurance, and education from an early age.[24-26] Based on these studies, NKDs are currently in more impoverished condition than the low-income SK families, and these economic conditions are thought to have influenced the nutritional and growth status of children of the NKD families. Higher meal skipping rate and inadequate meals of NKD families is thought to be the cause of malnutrition. These results showed that children and adolescents of the NKD families are in the economically vulnerable group due to difficulties in adapting after settlement in SK society,[27] still experience malnutrition due to inadequate food and nutrition uptake, and are thought to be in poor nutritional status compared to the original SK children. Improvement in the nutritional status of children and adolescents of the NKD families is needed through continuous follow-up.

There are some limitations to this study. The results are hard to generalize to the whole children and adolescents of the NKD families because the participants were not sampled through random sampling but convenience sampling. Also, variables such as the educational level of the parents that could influence nutritional status of children and adolescents could not be collected were not collected.

Despite these limitations, This study is significant in that it is the first large-scale comparison of the nutritional status of children and adolescents of SK families and those of NKD families after they entered and settled in SK.

In conclusion, the nutritional status of children and adolescents form NKD families was worse than that of those from SK families, and also higher prevalence of obesity.

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Not applicable.

CONTRIBUTORSHIP STATEMENT

SWC and SYK conceived the idea. SWC and SYK collected data and performed literature search. JP, SYR, MAH, and SYP developed analysis plan. SYK analyzed the data under the supervision of SWC. SYK drafted the paper. All authors contributed to the interpretation of results and in making an important intellectual contribution to the

manuscript. All authors read and approved the final manuscript.

COMPETEING INTERESTS

None declared.

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Ethics Approval

The study procedures were approved by the Bioethical Committee of Chosun University (IRB No. 2-1041055-AB-N-01-2017-0025).

Data availability statement

Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi: 10.5061/dryad.cfxpnvx61

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-9
		(b) Give reasons for non-participation at each stage	6-9
		(c) Consider use of a flow diagram	6-9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-9
		(b) Indicate number of participants with missing data for each variable of interest	6-9
Outcome data	15*	Report numbers of outcome events or summary measures	6-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-9

		(*b*) Report category boundaries when continuous variables were categorized	6-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9-11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.